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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/652,533	08/31/2000	Gurtej S. Sandhu	MI22-1385	4487

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EXAMINER

COLEMAN, WILLIAM D

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 09/04/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application N

09/652,533

Applicant(s)

SANDHU ET AL.

Examiner

W. David Coleman

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 03 July 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-43 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-43 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

## DETAILED ACTION

### *Response to Arguments*

1. Applicant's arguments filed July 3, 2002 have been fully considered but they are not persuasive.
2. Applicants contend that claims 1, 18, 26 and 31 sets forth a deposition method that includes, among other features, at a first temperature, contacting a substrate with a surface activation agent and adsorbing a first layer over the substrate. At a second temperature greater than the first temperature, the first layer is contacted with a first precursor and a second layer is chemisorbed at least one monolayer thick over the substrate. Applicant contends that Aarik et al., "Effect of growth conditions on formation of TiO<sub>2</sub>-II films in atomic layer depositions process", Journal of Crystal Growth, vol., 181, pp. 259-264, May 1997, herein known as Aarik, fails to disclose or even suggest the alleged teachings. Applicants contend that Aarik nowhere shows a first temperature of 425<sup>0</sup>C with TiCl<sub>4</sub> and a second temperature at 700<sup>0</sup>C with H<sub>2</sub>O.
3. In response to Applicants contention that the reference fails to teach the features at a first temperature, contacting a substrate with a surface activation agent and adsorbing a first layer over the substrate. At a second temperature greater than the first temperature, the first layer is contacted with a first precursor and a second layer is chemisorbed at least one monolayer thick over the substrate. More specifically, Aarik shows a first temperature of 425<sup>0</sup>C with TiCl<sub>4</sub> and a second temperature at 700<sup>0</sup>C with H<sub>2</sub>O. The Experimental Procedure discloses TiCl<sub>4</sub> and H<sub>2</sub>O being deposited at 425<sup>0</sup>C on page 260 and on page 263 Aarik teaches "that temperatures as high as 7000C are needed to cause partial phase transition from TiO<sub>2</sub>-II to rutile in the case of ALD-grown films". Applicants further disclose that "Often, traditional ALD occurs within an often

used range of temperature and pressure and according to established purging criteria at a time” (see Applicants disclosure, page 9, lines 1-6). The term “traditional” is equivalent to *conventional*. Aarik teaches depositing  $\text{TiCl}_4$  and discloses  $\text{TiO}_2\text{-II}$  at a second temperature which is higher than the first temperature. Since traditional ALD occurs within a range of temperature. Since traditional ALD deposits on monolayer at a time Aarik deposits at least one monolayer. For example Aarik deposits a monolayer of  $\text{TiCl}_4$  at  $425^\circ\text{C}$  and a monolayer of  $\text{H}_2\text{O}$  initially at  $425^\circ\text{C}$  then Aarik teaches to form  $\text{TiO}_2\text{-II}$  the temperature is now disclosed as  $700^\circ\text{C}$ . Since  $\text{H}_2\text{O}$  is the second precursor and the resulting two (2) monolayers form  $\text{TiO}_2\text{-II}$ , it is inherent that Aarik exposes the second deposited monolayer at a higher temperature than the first precursor monolayer. Aarik discloses a range of temperature with at least a lower temperature for the deposition of  $\text{TiCl}_4$  and  $\text{H}_2\text{O}$  and a higher temperature for the formation of  $\text{TiO}_2\text{-II}$ , therefore Applicants arguments are moot.

4. Applicants contend that only the “Experimental procedure” of the Aarik reference is the sole basis of the prior art rejection. Applicants contend that in the “Experimental procedure” section, there is no disclosure of contacting with  $\text{H}_2\text{O}$  at  $700^\circ\text{C}$ .

5. In response to Applicants contention that only the “Experimental procedure” is the sole basis of the prior art rejection, please see MPEP 2131. **TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM.** Applicants should understand that the reference as a whole and not a particular section of a reference is used as a basis of the rejection. Furthermore 35 CFR § 1.104(c) (3) states that in rejecting claims the examiner may rely upon admissions by the applicant, or the patent owner in a reexamination proceeding, as to any matter affecting patentability and, insofar as rejections in applications are

concerned, may also rely upon facts within his or her knowledge pursuant to paragraph (d) (2) of this section. For example, it is well known that semiconductor process chambers have fixed volumes (i.e., the size of the deposition chamber does not change under normal processing conditions). It is well known that according to Boyle's law and Charles's law respectively, volume is inversely proportional to pressure  $V \propto 1/P$  and volume is proportional to temperature,  $V \propto T$ . Since the deposition chamber (i.e., semiconductor processing chamber) has a fixed volume only two variables can be changed, that is either pressure or temperature. In this particular case, Aarik teaches that ALD films can be controlled by either the pressure or temperature and teaches the phrase "temperature range" as disclose in the "Introduction".

6. Applicants contend that claim 5 sets forth that the first temperature is less than a chemisorption temperature of the surface activation agent on the substrate and that Aarik does not provide any disclosure or even a suggestion of such a feature of the first temperature. That is, Aarik does not disclose or suggest that  $425^{\circ}\text{C}$  is less than the chemisorption temperature of  $\text{TiCl}_4$ , the alleged surface activation agent.

7. In response to Applicants contention, that Aarik does not disclose or suggest that  $425^{\circ}\text{C}$  is less than the chemisorption temperature of  $\text{TiCl}_4$ , the alleged surface activation agent, please note the following. Applicant discloses on page 11, lines 10-17 that chemisorption refers to a type of adsorption in which chemical bonds are formed between solid, liquid or gas molecules, atoms, or ions and a solid or liquid surface. The chemical bonds may be weak chemical bonds. Aarik discloses a substrate (i.e., solid surface) and covering that surface with  $\text{TiCl}_4$  (i.e., a gas). Since  $\text{TiCl}_4$  sticks to the substrate (weak chemical bond) chemisorption occurs at a temperature

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of 425<sup>0</sup>C. Because the chlorine is not permanently bonded to the substrate at 425<sup>0</sup>C this temperature discloses that chlorine does not form a strong or permanent bond with the substrate.

8. Applicants contend that the cited text does not provide any other discussion of the significance of temperature.

9. In response to Applicants contention that the cited reference does not provide any other discussion of the significance of temperature, please note the following. Aarik discloses that data of previous experiments [7,8] have shown that temperatures as high as 700<sup>0</sup>C are needed to cause partial phase transition from TiO<sub>2</sub>-II to rutile in the case of ALD-grown films. Since Aarik teaches forming TiCl<sub>4</sub> at 425<sup>0</sup>C and a temperature as high as 700<sup>0</sup>C to cause partial phase transition of TiO<sub>2</sub>-II to rutile in the case of ALD films temperature appears to be critical.

10. Applicant contend that claim 12 sets forth that the method includes substantially displacing the first layer from over the substrate during the chemisorbing the second layer.

11. In response to Applicants contention that Aarik does not provide any disclosure or even suggest displacing the first layer, the chlorine in the titanium gas is displaced by the oxygen of the second layer wherein the second layer is H<sub>2</sub>O and the first layer is TiCl<sub>4</sub>.

12. Applicant contends that claims 13 depends on claim 1 and sets forth that the surface activation agent is the same as the first precursor and that Aarik fails to disclose the surface activation agent is the same as the first precursor.

13. In response to Applicants contention that the first precursor of Aarik is not the activation agent, please note the following: Aarik teaches that TiCl<sub>4</sub> a precursor (see abstract) and an activation agent. TiCl<sub>4</sub> reacts or gets activated with H<sub>2</sub>O by a surface reaction via OH-groups which reduce the Cl/Ti ratio in the surface intermediate layer formed during TiCl<sub>4</sub> pulse.

14. Applicants contend that in claim 31 Aarik does not disclose or suggest contacting a bulk semiconductor wafer with a cooling medium.

15. In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, Doering reveals contacting a bulk semiconductor wafer with a cooling medium.

***Claim Rejections - 35 USC § 102***

16. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

17. Claims, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 and 30 are rejected under 35 U.S.C. 102(b) as being anticipated by Aarik et al., "Effect of growth conditions on formation of TiO<sub>2</sub>-II films in atomic layer depositions process", Journal of Crystal Growth, vol., 181, pp. 259-264, May 1997.

18. Pertaining to claims 1, 2, 18 and 19, Aarik discloses a deposition method as claimed. Aarik teaches a deposition method comprising:

at a first temperature ( $425^{\circ}\text{C}$ ), contacting a substrate with a surface activation agent ( $\text{TiCl}_4$ ) and adsorbing a first layer over the substrate; and

at a second temperature greater than the first temperature ( $700^{\circ}\text{C}$ ), contacting the first layer with a first precursor ( $\text{H}_2\text{O}$ ) and chemisorbing a second layer at least one monolayer thick over the substrate.

19. Pertaining to claim 26, Aarik teaches a deposition method comprising:

adsorbing a surface activation agent over a substrate, at least an outer surface of the substrate being at a first temperature less than a chemisorption temperature of the agent;

altering a temperature of at least a portion of the substrate;

chemisorbing a monolayer of a first compound over the substrate, at least an outer surface of the substrate being at a second temperature greater than the first temperature, and substantially displacing the agent from over the substrate; and

chemisorbing a monolayer of a second compound on the first compound monolayer.

20. Pertaining to claims 3, 4, 20, 21, 28 and 29, Aarik teaches wherein the surface activation agent comprises a metal halide comprising  $\text{TiCl}_4$ .

21. Pertaining to claim 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 22, 23, 24, 25, 27 and 30 Aarik teaches wherein the first temperature is less than a chemisorption temperature of the surface activation agent on the substrate (see Introduction, second paragraph). The substrate comprises a bulk semiconductor wafer (111 silicon, Experimental procedure). The surface activation agent is the same as the first precursor, which consist of a monolayer. The first layer is substantially displaced from over the substrate during chemisorbing the second layer, hence ( $\text{TiO}_2$  formation).

***Claim Rejections - 35 USC § 103***



22. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

23. Claims 16 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Aarik et al., "Effect of growth conditions on formation of TiO<sub>2</sub>-II films in atomic layer depositions process", Journal of Crystal Growth, vol., 181, pp. 259-264, May 1997, as applied to claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 and 30 above, and further in view of Sherman, U.S. Patent 5,916,365.

24. Aarik discloses a semiconductor process substantially as claimed as discussed above. However, Aarik fails to teach contacting a second layer with a second precursor and chemisorbing a third layer at least on monolayer thick on the second layer, forming a chemisorption product of the first and second precursors comprising a deposition material. Sherman teaches contacting the second layer with a second precursor and chemisorbing a third layer at least one monolayer thick on the second layer, forming a chemisorption product of the first and second precursors comprising a deposition material. See **Example 3** of Sherman, where three or more elements such as oxynitrides by sequentially growing an oxide and then growing a nitride is disclosed. In view of Sherman, it would have been obvious to one of ordinary skill in the art to incorporate the semiconductor process of Sherman into the Aarik semiconductor process because the provides growing oxynitrides by atomic layer deposition (column 8, lines 9-15).

25. Claims 31, 34, 36, 38, 39, 40, 41, 42 and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Aarik et al., "Effect of growth conditions on formation of TiO<sub>2</sub>-II films in atomic layer depositions process", Journal of Crystal Growth, vol., 181, pp. 259-264, May 1997, in view of Doering et al., U.S. Patent 6,174,377 B1.
26. Pertaining to claims 31 and 34, Aarik discloses a semiconductor process substantially as claimed.
27. A deposition method comprising:  
contacting a bulk semiconductor wafer with a cooling medium (purging gas via adsorption trap cooled down to 100K) to establish at least an outer surface with a surface activation agent and adsorbing a first layer on the wafer, the initial temperature being less than a chemisorption temperature of the agent;  
contacting the first layer with a deposition precursor and chemisorbing a second layer at least one monolayer thick over the wafer. However, Aarik fails to disclose placing a wafer on a heated wafer chuck. Doering teaches placing a wafer on a heated wafer chuck, see **FIG. 10B** of Doering where wafers(not shown) are heated. In view of Doering, it would have been obvious to one of ordinary skill in the art to place wafers on a heated chuck because the Examiner believes that heating is required to form an oxide film.
28. Pertaining to claim 36, Doering discloses wherein there are multiple chambers for the fabrication of atomic layer deposition films (see **FIG. 10A** of Doering).

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Pertaining 38, 39, 40, 41, 42 and 43 Aarik teaches wherein the first layer enhances a chemisorption rate of the deposition precursor compared to the wafer without the surface activation agent adsorbed thereon (i.e., it is well known that monolayer of oxygen are always forming on silicon because of there strong bond and by heating the wafer, the process reduces that particular chemisorption rate). Aarik also discloses a metal halide comprising  $\text{TiCl}_4$  wherein the surface activation agent is the same as the deposition precursor. Aarik discloses wherein the second layer consist essentially of a monolayer.

29. Pertaining to claims 32, 33, 35 and 37, the combined teaches discloses a semiconductor process substantially as claimed. However, Aarik fails to disclose elevating the wafer over the heated wafer chuck, placing the wafer on a cooled wafer chuck different from the heated wafer chuck by robotic linear translation. Doering teaches a method wherein elevating the wafer over the heated wafer chuck, placing the wafer on a cooled wafer chuck different from the heated wafer chuck by robotic linear translation. See **FIGS. 2-23** of Doering where a processing station adaptable to standard cluster tools has a robotic linear translation for different wafer chucks (i.e., one for heating and one for cooling). In view of Doering, it would have been obvious to one of ordinary skill in the art to incorporate the semiconductor apparatus of Doering in the teachings of Aarik, for the processing of ALD films (see Title).

#### *Conclusion*

30. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

31. A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO**

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MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

32. Any inquiry concerning this communication or earlier communications from the examiner should be directed to W. David Coleman whose telephone number is 703-305-0004.

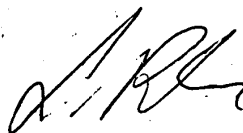
The examiner can normally be reached on 9:00 AM-5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael M. Fahmy can be reached on 703-308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7721 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



WDC  
August 30, 2002



LONG PHAM  
PRIMARY EXAMINER